No. 6

The Engineering Standards Committee

PROPERTIES

OF

BRITISH STANDARD SECTIONS

JULY, 1904

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BRITISH STANDARD SECTIONS

ISSUED BY

THE

Engineering Standards Committee

Supported by—

THE INSTITUTION OF CIVIL ENGINEERS.
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PROPERTIES OF BRITISH STANDARD SECTIONS

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PREFACE

The Engineering Standards Committee was appointed in April, 1901, by the Institution of Civil Engineers, to enquire into the advisability of standardising rolled Iron and Steel Sections for Structural purposes. The Committee sat to hear evidence from Engineers, Manufacturers, and others, and, as the facts laid before them were overwhelmingly in favour of Standardisation, it was unanimously decided to proceed. It was found that the work could not conveniently be dealt with by one Committee, and the three following Committees were therefore appointed :—

1. Committee on SECTIONS USED IN SHIPBUILDING, presided over by Mr ARCHIBALD DENNY, one of the official representatives of the Institution of Naval Architects on the Engineering Standards Committee.
2. Committee on BRIDGES AND GENERAL BUILDING CONSTRUCTION, presided over by Sir BENJAMIN BAKER, K.C.B., one of the official representatives of the Institution of Civil Engineers.
3. Committee on SECTIONS USED IN RAILWAY ROLLING STOCK UNDERFRAMES, presided over by Sir DOUGLAS FOX, also an official representative of the Institution of Civil Engineers.

These Committees sat separately in the first instance and drew up independent lists of the proposed Standard Sections ; each list being designed to meet the requirements of the class of work with which the Committees were dealing. When these lists had been drawn up, joint meetings were held and a list arrived at, designed, as far as possible, to meet the combined requirements of all three Committees.

The object the Engineering Standards Committee had in view was to include a sufficient number of sizes in the Standard Lists to ensure a satisfactory graduation for all practical purposes, whilst at the same time reducing, as far as possible, the

number of rolls which Steel Makers would find it necessary to keep. Certain sizes which, from a graduation point of view, should have found a place in the Standard Lists, were excluded as being little used in general practice. Others, again, were retained on account of their extensive use in this country, though their retention interfered with systematic graduation.

Several sizes, which were in frequent use for some particular purpose, were excluded from the Standard Lists, as they were not in sufficiently general demand to warrant their inclusion, and it was felt that in any case a certain number of makers would continue to keep rolls for these sections.

STANDARD THICKNESSES

The question of giving more than one Standard thickness for any particular size was carefully considered, and it will be noted that in several of the lists, minimum, mean, and maximum sizes are given, the Steel Makers being able to cut their rolls in such a manner that the section should have a correct profile at these standard thicknesses. This refers to Equal Angles, Unequal Angles, and Tee Bars. If thicknesses above or below the Standard are rolled, the lengths of flanges or webs will be altered accordingly, and in the case of Angles and Zed bars the outer edges will be slightly bevelled.

The moments of inertia and moments of resistance have been calculated only for the minimum standard thicknesses ; for other thicknesses those values would increase approximately in proportion to the sectional areas or weights as explained on page 11.

The Committee recommend that *all material be ordered by weight per foot run in combination with the overall dimensions* **A** and **B**, given in column 2 of the tables.

All the formulæ upon which the calculations for the properties of the Standard Sections were made, were drawn up by Mr MAX AM ENDE, of the Calculation Committee.

British Standard Sections

DEFINITIONS AND FORMULÆ

SYMBOLS

a Area of the section in inches^2

I_x I_y Moments of inertia of the section in inches^4 about the axes **x** – **x**, **y** – **y**, etc. passing through the centre of gravity of the section. These axes may be called *central axes.*

i_x i_y Radii of gyration, in inches.

R_x R_y Moments of resistance, in inches^3

α Angle enclosed between two central axes.

c Distance of the centre of gravity of the section from a given axis.

e Distance of an extreme point of the section (i.e., an extreme fibre of the beam) from a central axis.

W and **P** Loads in tons.

M Bending moment in inch-tons.

l Length of a bar or beam in inches.

s and σ Stresses per square inch in tons.

E Modulus of elasticity of the material in tons per square inch.

MOMENTS OF INERTIA

The moment of inertia of a plane figure about an axis **O – O** (FIG. 1) is the sum of the products $\mathbf{y^2 . z\, dy}$, where $\mathbf{z\, dy}$ is the area of any one of the thin laminæ into which the figure can be divided. The sum $\Sigma\, \mathbf{y^2 . z \Delta y}$ represents approximately the moment of inertia, $\Delta \mathbf{y}$ being a measurable width. This arithmetical expression must be used if the figure is enclosed by curves which cannot be defined mathematically. The mathematically accurate expression is :

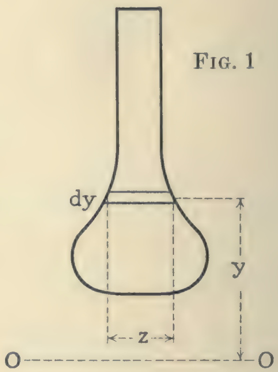


FIG. 1

$$\mathbf{I} = \int \mathbf{y^2 . z\, dy} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where **dy** is infinitesimal. This expression has been used for the calculation of the moments of inertia of the Standard Sections, as they have, without exception, accurately defined outlines.

The moments of inertia of a figure are, as a rule, those calculated about the central axes, *i.e.*, axes passing through the centre of gravity of the figure.

i, the radius of gyration of a figure or section, is a length defined by the following equation :

$$\mathbf{i^2 a = I} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If, in equation (1), **i**, a fixed distance from the centre of gravity, is put in place of **y**, so that $\int \mathbf{y^2 z\, dy} = \mathbf{i}^2 \int \mathbf{z\, dy}$, then the sum of $\int \mathbf{z\, dy}$ represents the area **a** as a lamina of the infinitely small width **dy** at the distance **i**, and $\mathbf{i^2 a}$ is the moment of inertia of the figure.

THE ELLIPSE OF INERTIA

Generally the radius of gyration, **i**, varies in length as the central axis is turned about the centre of gravity. The lamina representing the area **a** moves as a tangent to an ellipse, and **i** is thereby determined. This ellipse is called the *ellipse of inertia* of the figure. In some special cases the ellipse assumes the form of a circle. Fig. 2 shows an ellipse with radii i_x, i_y and i_w, and their corresponding tangents.

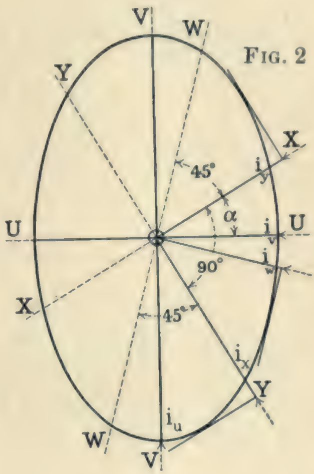


FIG. 2

The major and minor axes of the ellipse coincide with the largest and smallest radii of gyration i_u and i_v. If these are known, the length of any other radius of gyration, i_x, inclined at an angle α to i_u, is given by the equation :

$$i_x^2 = i_u^2 - \sin^2\alpha \, (i_u^2 - i_v^2) \quad . \quad . \quad . \quad . \quad (3)$$

and i_y, at right angles to i_x, by the equation :

$$i_y^2 = i_u^2 - \cos^2\alpha \, (i_u^2 - i_v^2) \quad . \quad . \quad . \quad . \quad (3a)$$

The addition of (3) and (3a) gives :

$$i_x^2 + i_y^2 = i_u^2 + i_v^2 \; ;$$

and multiplied by the area **a** :

$$I_x + I_y = I_u + I_v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

that is to say :—*the sum of any two moments of inertia of a section about axes at right angles to each other is a constant quantity.*

Sections having an axis of symmetry. In these cases, for example in the case of an Equal Angle, either the major or the minor axis of the ellipse of inertia coincides with the axis of symmetry. The position of the axes of the Ellipse is therefore determined.

Sections having no axis of symmetry. In these cases, for example in the case of an Unequal Angle, the position of the major axis of the ellipse can only be determined by means of three moments of inertia. If $\mathbf{I}_x$ and $\mathbf{I}_y$ are two given moments of inertia on axes at right angles to each other, and if $\mathbf{I}_w$ is one on an axis inclined at an angle of 45° to both, the angle a (Fig. 2) is determined by the following formula :

$$\tan 2a = \frac{\mathbf{I}_x + \mathbf{I}_y - 2\mathbf{I}_w}{\mathbf{I}_y - \mathbf{I}_x} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$\mathbf{I}_u$ and $\mathbf{I}_v$ can then be calculated from the two following formulæ :

$$\left.\begin{aligned} \mathbf{I}_u &= \frac{1}{2}\left(\mathbf{I}_x + \mathbf{I}_y + \frac{\mathbf{I}_x - \mathbf{I}_y}{\cos 2a}\right) \\ \mathbf{I}_v &= \frac{1}{2}\left(\mathbf{I}_x + \mathbf{I}_y - \frac{\mathbf{I}_x - \mathbf{I}_y}{\cos 2a}\right) \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (6)$$

Parallel displacement of axes. Let $\mathbf{I}_x$ be the moment of inertia about the central axis $\mathbf{x} - \mathbf{x}$ and let $\mathbf{m} - \mathbf{m}$ be an axis parallel to $\mathbf{x} - \mathbf{x}$ and at a distance $\mathbf{c}_m$ from it, then the moment of inertia $\mathbf{I}_m$ about $\mathbf{m} - \mathbf{m}$ is :

$$\mathbf{I}_m = \mathbf{I}_x + \mathbf{a}\mathbf{c}_m^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

If $\mathbf{I}_x$ is not given, but only $\mathbf{I}_m$ and $\mathbf{c}_m$, any moment of inertia $\mathbf{I}_n$ about an axis $\mathbf{n} - \mathbf{n}$, parallel to and at a distance $\mathbf{c}_n$ from $\mathbf{x} - \mathbf{x}$, can be calculated from the following formula :

$$\mathbf{I}_n = \mathbf{I}_m + \mathbf{a}\,(\mathbf{c}_n^2 - \mathbf{c}_m^2) \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Moments of inertia of compound sections. Let $\mathbf{a}_1$, $\mathbf{a}_2$, ... $\mathbf{a}_n$ be the areas of the component sections ; $\mathbf{I}_1$, $\mathbf{I}_2$, ... $\mathbf{I}_n$ the moments of inertia about their central axes ; $\mathbf{c}_1$, $\mathbf{c}_2$ .... $\mathbf{c}_n$ the distances of their central axes from an assumed parallel axis **O – O** ; let $\mathbf{I}_x$ be the moment of inertia of the compound section about its central axis, and $\mathbf{c}_x$ the distance of its central axis from **O – O**, then :—

$$\mathbf{c} = \frac{\mathbf{a}_1\mathbf{c}_1 + \mathbf{a}_2\mathbf{c}_2 + \ldots.\ \mathbf{a}_n\mathbf{c}_n}{\mathbf{a}_1 + \mathbf{a}_2 + \ldots.\ \mathbf{a}_n} \quad . \quad . \quad . \quad . \quad (9)$$

and according to (8) :

$$\mathbf{I}_x = \mathbf{a}_1(\mathbf{c}_x - \mathbf{c}_1)^2 + \mathbf{a}_2(\mathbf{c}_x - \mathbf{c}_2)^2 + \ldots + \mathbf{a}_n(\mathbf{c}_x - \mathbf{c}_n)^2 + \mathbf{I}_1 + \mathbf{I}_2 + \ldots \mathbf{I}_n \quad (9a)$$

EXAMPLE

Fig. 3 is a compound section, composed of the Bulb Plate No. 7, List 5, the two Angles No. 9, List 1, and the Channel No. 22, List 7. These three lists give the following values:

$a_1 = 8{\cdot}652$

$a_2 = 2{\cdot}880$

$a_3 = 8{\cdot}771$

$c_1 = 5{\cdot}100$

$c_2 = 11{\cdot}173$

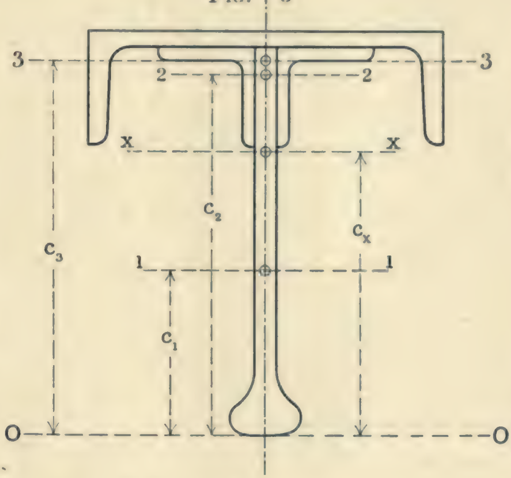
$c_3 = 11{\cdot}579$

$I_1 = 121{\cdot}398$

$I_2 = 2{\cdot}414$

$I_3 = 8{\cdot}421$

Fig. 3



These values put into (9) and (9a) give

$$c_x = 8{\cdot}761 \text{ and } I_x = 334{\cdot}602$$

Method of calculating the Standard Sections. The Standard Sections have been calculated in this way as compound sections, inasmuch as they are composed of rectangles, triangles, and sectors of circles, which may be either positive or negative. The algebraic expressions for **a**, **c** and **I** of these elements have been arranged according to equations (7), (8), (9) and (9a) so as to make a set of formulæ for each of the nine standard types, and the numerical calculations have been made according to these formulæ.

The calculations have only been made for the *minimum* Standard thicknesses of Lists 1, 2 and 9. Approximate moments of inertia and moments of resistance for other thicknesses can easily be obtained from the given values by multiplying them by the ratios of the weights (or sectional areas). This is

preferable to using the ratios of the thicknesses, as is shown by the following table, which gives the values corresponding to the maximum standard thickness for the Equal Angle 3 in. × 3 in. × $\frac{1}{2}$ in., No. 9, List 1.

METHOD OF CALCULATION	I_x and I_y	I_u	I_v	R_x and R_y
From Formula	2·179	3·441	·918	1·052
Min. Values × $\frac{\text{Max. Weight}}{\text{Min. Weight}}$	2·306	3·666	·945	1·060
Min. Values × $\frac{\text{Max. Thickness}}{\text{Min. Thickness}}$	2·414	3·838	·990	1·110

The method of using the ratio of the weights would also give good results for Bulb Angles and Z bars for other than the Standard thicknesses, but for Bulb Tees, Bulb Plates, Channels and Beams more accurate results are obtained for I_x by adding the quantity $\frac{A^3}{12}b$ where b is the increase of t_1.

ELASTIC RESISTANCE OF STRUTS

The theory of struts gives the following formula :

$$W = \frac{E\,I}{l^2}\pi^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

l is the length of the strut between rounded ends, or the distance between the points of change of flexure, and W is the weight in tons which the strut will carry without bending. The weight is then equally distributed over the cross section and the stress per square inch is :

$$s = \frac{W}{a}$$

If W is increased, and the strut bends in consequence of any irregularity or accident, bending will generally take place in the direction of the smallest radius of gyration,

$$i_v = \sqrt{\frac{I_v}{a}}$$

and the amount of bending will be indefinite. The above formula can now be written as follows :

$$\mathbf{s} = \mathbf{E}\,\pi^2 \left(\frac{i_v}{l}\right)^2 \quad . \quad . \quad . \quad . \quad . \quad (10a)$$

The modulus of elasticity of steel, **E**, which may be taken as about 14,000 tons, is the stress which would extend a bar of one square inch in section to double its length, if the limit of elasticity had not been reached at a smaller stress.

The curve **A B** (FIG. 4) is a graphical illustration of the formula (10a) for steel.

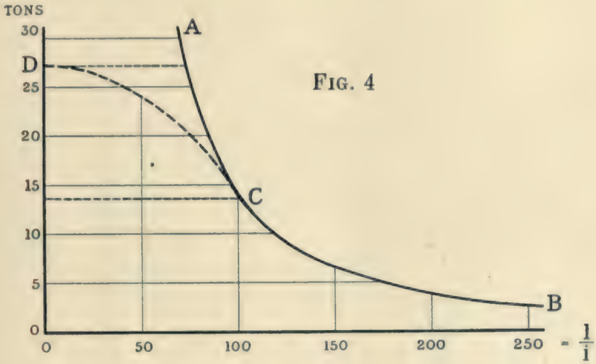


FIG. 4

At a point **C** on the curve, where the limit of elasticity is reached, which, for mild steel, may be taken at $\mathbf{s} = 13{\cdot}5$ tons, or about $\frac{i}{l} = \frac{1}{100}$ and for harder steel at a higher point, the curve indicating the *actual* resistance of the strut will take a course towards **D**, *i.e.* towards the point $\frac{i}{l} = \frac{1}{0}$ where **s** is equal to the breaking stress of the material.

Some formulæ used in practice for the calculation of the resistance of struts consist, therefore, of two parts, one for the branch **C B** of the curve according to (10a), and the other for the branch **C D** derived from experiment. Other formulæ have been established for the whole range of the values $\frac{i}{l}$ by means of a single expression. Such formulæ, however, cannot be made to coincide with the branch **CB** of the original curve.

MOMENTS OF RESISTANCE

The moment of resistance of a sectional figure is an expression which is used to calculate the greatest stress produced in a section of a beam by a given bending moment, viz. :

$$\mathbf{R} = -\frac{\mathbf{M}}{\mathbf{s}};\ \mathbf{s} = -\frac{\mathbf{M}}{\mathbf{R}} \quad . \ . \ . \ . \ . \ . \ . \quad (11)$$

In FIGS. 5 and 5a **A B C D** is a straight beam of uniform section.

FIG. 5

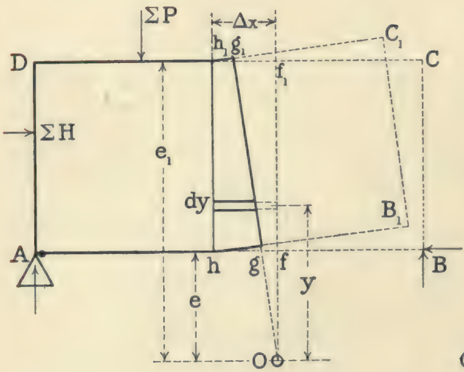


FIG. 5a

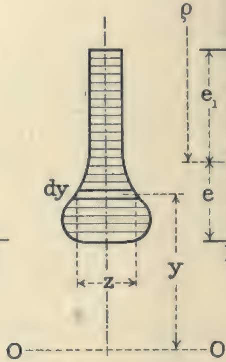
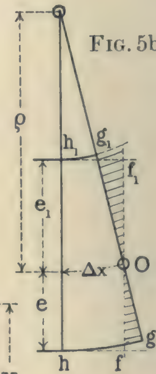


FIG. 5b



$\mathbf{hh_1}$ and $\mathbf{ff_1}$ are two parallel sections at a small distance $\Delta\mathbf{x}$ from each other. The forces acting on the portion to the left of $\mathbf{ff_1}$ are the resultants of the vertical and horizontal forces $\Sigma\,\mathbf{P}$ and $\Sigma\,\mathbf{H}$, as also the abutment reaction **A** and the stresses in the section $\mathbf{ff_1}$. In consequence of the stresses the straight fibres of the beam become curved, and the section $\mathbf{ff_1}$ moves to $\mathbf{gg_1}$, turning upon an axis **O – O**, the end of the beam moving from **BC** to $\mathbf{B_1\,C_1}$. (The bending of the beam outside $\Delta\mathbf{x}$ has been disregarded in the diagram.)

The vertical shearing stress **S** in the section $\mathbf{g\,g_1}$ is the sum of all vertical forces to the right. The horizontal stresses in the thin laminæ **z dy** will be in proportion to the compression **f g** of each, *i.e.*, in proportion to their distances **y** from **O – O**.

Therefore, if σ is the stress per square inch at the distance 1, the stress in the laminæ $\mathbf{z\,dy}$ will be $\sigma\,\mathbf{y\,z\,dy}$ and its statical moment $\sigma\,\mathbf{y^2z\,dy}$. Accordingly, the total horizontal stress on the section $\mathbf{h\,h_1}$ will be $\sigma\int_{e}^{e_1}\mathbf{y\,z\,dy}$ and its statical moment $\sigma\int_{e}^{e_1}\mathbf{y^2z\,dy}$.

All forces and their statical moments acting on the portion of the beam to the left of $\mathbf{g\,g_1}$ are now determined, and the conditions of equilibrium can be stated as follows:

$$\mathbf{S} + \mathbf{A} + \Sigma\mathbf{P} = 0 \quad . \quad . \quad . \quad . \quad . \quad (12a)$$

$$\Sigma\mathbf{H} + \sigma\int_{e}^{e_1}\mathbf{y\,z\,dy} = 0 \quad . \quad . \quad . \quad (12b)$$

$$\mathbf{M} + \sigma\int_{e}^{e_1}\mathbf{y^2z\,dy} = 0 \quad . \quad . \quad . \quad . \quad (12c)$$

where $\mathbf{M}$ is the sum of the statical moments of the forces $\mathbf{A}$, $\mathbf{P}$, $\mathbf{H}$ and $\mathbf{S}$ about the axis $\mathbf{O-O}$.

If there are no horizontal forces, the above equations will be as follows:

$$-\mathbf{S} = \mathbf{A} + \Sigma\mathbf{P} \quad . \quad . \quad . \quad . \quad . \quad . \quad (13a)$$

$$\int_{e}^{e_1}\mathbf{y\,z\,dy} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13b)$$

$$-\mathbf{M} = \sigma\int_{e}^{e_1}\mathbf{y^2z\,dy} \quad . \quad . \quad . \quad . \quad (13c)$$

$\int_{e}^{e_1}\mathbf{y\,z\,dy}$ is the statical moment of the section, and the equation (13b) shows that the axis $\mathbf{O-O}$ lies in its centre of gravity (FIG. 5b.) The fibres between 0 and $\mathbf{e}$ are in tension, and the fibres between 0 and $\mathbf{e_1}$ in compression; $\int_{e}^{e_1}\mathbf{y^2z\,dy}$ is the moment of inertia $\mathbf{I}$ of the section; hence: $-\mathbf{M} = \sigma\,\mathbf{I}$.

As $\sigma\,\mathbf{y}$ was stated to be the stress per square inch at $\mathbf{y}$, so $\sigma\,\mathbf{e}$ is the tensile stress $\mathbf{s}$ at $\mathbf{e}$, and $\sigma\,\mathbf{e_1}$ the compressive stress $\mathbf{s_1}$ at $\mathbf{e_1}$. Both are maximum stresses on the section.

$$\text{Hence} \quad -\mathbf{M} = \frac{\mathbf{I}}{\mathbf{e}}\mathbf{s} \text{ and } -\mathbf{M} = \frac{\mathbf{I}}{\mathbf{e_1}}\mathbf{s_1} \quad . \quad . \quad . \quad . \quad (14)$$

and from equation (11):

$$\mathbf{R} = \frac{\mathbf{I}}{\mathbf{e}} \text{ and } \mathbf{R_1} = \frac{\mathbf{I}}{\mathbf{e_1}} \quad . \quad . \quad . \quad . \quad (15)$$

RADIUS OF CURVATURE

The curvature which the fibres of a straight beam assume under the action of bending moments generally varies from point to point ; but assuming the length $\Delta \mathbf{x}$, (FIG. 5b) to be so small that the alteration of the radius of curvature within it can be ignored, then ρ is determined by the turning of the section $\mathbf{ff_1}$ into the position $\mathbf{gg_1}$, and from (FIG. 5b) follows :

$$\frac{\rho}{\rho + e} = \frac{\Delta x}{hg} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

As $\mathbf{hf} = \Delta \mathbf{x}$, if $\Delta \mathbf{x}$ is very small, the elongation $\mathbf{fg}$ of $\mathbf{hf}$ will be equal to $\frac{\mathbf{s}}{\mathbf{E}} \Delta \mathbf{x}$, and :

$$\mathbf{hg} = \left(1 + \frac{\mathbf{s}}{\mathbf{E}}\right) \Delta \mathbf{x} \, ;$$

equation (16) then gives :

$$\rho = \frac{e}{s} \mathbf{E} \, ;$$

and from equation (14)

$$\rho = -\frac{\mathbf{EI}}{\mathbf{M}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

DEFLECTION OF A BEAM

The formula for the radius of curvature at a point $\mathbf{xy}$ of a curve is :

$$\frac{1}{\rho} = \frac{d^2y}{dx^2}$$

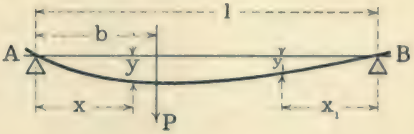
Substituting this in equation (17) the following equation of the curve of deflection, also called the equation of the elastic line, is obtained :

$$\frac{d^2y}{dx^2} = -\frac{\mathbf{M}}{\mathbf{EI}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

The integration of this equation gives the deflection $\mathbf{y}$ at a point $\mathbf{x}$ if $\mathbf{M}$ can be stated in terms of $\mathbf{x}$.

EXAMPLE OF A BEAM WITH A SINGLE LOAD AT A GIVEN POINT

FIG. 6



In FIG. 6, A B represents a beam of the length l, freely supported at both ends. The load P is at the distance b from A.

Equation (18) has to be stated separately for the parts of the beam on the left and on the right side of P, viz. :

on the left : $$\frac{d^2y}{dx^2} = -\frac{P}{EI}\,\frac{l-b}{l}\,x \quad \ldots\ldots\ldots \quad (19)$$

and on the right : $$\frac{d^2y_1}{dx_1^2} = -\frac{P}{EI}\,\frac{b}{l}\,x_1 \quad \ldots\ldots\ldots \quad (19a)$$

These equations are integrated twice, and the constants appearing in the process of integration are determined by the conditions, that:

$$\frac{dy}{dx} = -\frac{dy_1}{dx_1} \text{ and } y = y_1$$

when $x = b$ and $x_1 = l - b$. The result is as follows :

$$y = \frac{P}{6\,EI}\cdot\frac{l-b}{l}\left[-x^3 + b\,(2l-b)\,x\right] \quad \ldots \quad (20)$$

$$y_1 = \frac{P}{6\,EI}\cdot\frac{b}{l}\left[-x_1^3 + (l-b)\,(l+b)\,x_1\right]. \quad \ldots \quad (20a)$$

The deflection at any point of the beam can be calculated from these formulæ. The point of maximum deflection of the beam is calculated from (20), if b is greater than $\frac{1}{2}l$, and from (20a), if b is less than $\frac{1}{2}l$, by putting the first differentials of those expressions equal to nil, viz :

$$\frac{dy}{dx} = 0 = -3x^2 + b\,(2l-b), \text{ or } x = \sqrt{\frac{b\,(2l-b)}{3}} \quad . \quad (21)$$

and $$\frac{dy_1}{dx_1} = 0 = -3x_1^2 + (l-b)\,(l+b), \text{ or } x_1 = \sqrt{\frac{(l-b)\,(l+b)}{3}} \quad (21a)$$

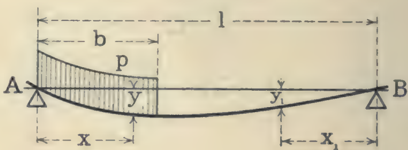
If the load is in the middle, *i.e.*, if $b = \frac{1}{2}l$, both equations (21 and 21a) give $x = \frac{1}{2}l$. These values, put into either (20) or (20a), give the deflection in the centre of the beam

$$y = \frac{P}{48\,EI}\;l^3$$

EXAMPLE OF A BEAM WITH A UNIFORMLY DISTRIBUTED LOAD

In FIG. 7 the load per foot run p, is distributed over the distance b, and here equation (18) has to be stated separately for the loaded and for the unloaded part of the beam, viz.:

FIG. 7



$$\text{loaded part: } \frac{d^2y}{dx^2} = -\frac{p}{EI}\left[\frac{b}{2l}(2l-b)\,x - \frac{x^2}{2}\right] \quad \ldots \quad (22)$$

$$\text{unloaded part: } \frac{d^2y}{dx_1^2} = -\frac{p}{EI}\cdot\frac{b^2}{2l}\,x_1 \quad \ldots \quad (22a)$$

By integrating twice, as in the previous example, the following results are obtained:

$$y = \frac{p}{24\,EI}\left[x^4 - \frac{2b}{l}(2l-b)\,x^3 + \frac{b^2}{l}(2l-b)^2 x\right] \quad \ldots \quad (23)$$

$$y_1 = \frac{p}{24\,EI}\cdot\frac{b^2}{l}\left[-2x_1^3 + (2l^2-b^2)\,x_1\right] \quad \ldots \quad (23a)$$

For the calculation of the maximum deflections the first differentials of these expressions are put equal to nil, viz.:

$$\frac{dy}{dx} = 0 = 4x^3 - \frac{6b}{l}(2l-b)\,x^2 + \frac{b^2}{l}(2l-b) \quad \ldots \quad (24)$$

$$\frac{dy_1}{dx_1} = 0 = -6x_1^2 + 2l^2 - b^2 \quad \ldots \quad (24a)$$

The maximum deflection will be at B, the end of the uniformly distributed load, when x_1 in (24a) equals $l - b$, *i.e.*, when:

$$-6\,(l-b)^2 + 2l^2 - b^2 = 0$$

$$b = \frac{6-\sqrt{8}}{7}\,l = \cdot 453\,l$$

This and $x_1 = l - b$ put into (23a) gives the corresponding deflection. If the load is distributed over the whole length of the beam, *i.e.*, if $b = l$, equation (23) gives:

$$y = \frac{p}{24\,EI}\,(x^4 - 2l\,x^3 + l^3 x)$$

The deflection in the middle, *i.e.*, if $x = \frac{1}{2}l$, is then as follows:

$$y = \frac{5}{384}\cdot\frac{p}{EI}\,l^4$$

MAX AM ENDE.

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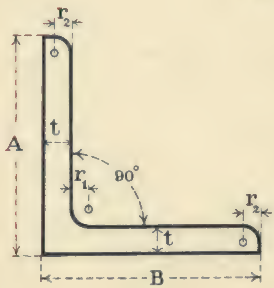
British Standard Sections

Lists 1 to 9

BRITISH STANDARD SECTIONS

EQUAL ANGLES



a = Sectional Area.

w = 3·4 **a** Weight in lbs. per foot.

1	2	3	4 | 5	6	7
Reference No. and Code Word	Size	Standard Thickness	Radii	Weight per foot	Sectional Area
	A × B	t	r_1 r_2	w	a
	inches	inches	inches	lbs.	inches²
BSEA 1 Abacist	1 × 1	·125 — ·250	·175 ·125	·80 — 1·49	·234 — ·437
BSEA 2 Aback	1¼ × 1¼	·125 — ·250	·200 ·150	1·02 — 1·92	·299 — ·564
BSEA 3 Abaddon	1½ × 1½	·125 — ·250	·200 ·150	1·23 — 2·34	·361 — ·689
BSEA 4 Abaft	1¾ × 1¾	·175 — ·300	·225 ·150	1·98 — 3·27	·583 — ·961
BSEA 5 Abandoning	2 × 2	·175 — ·300	·250 ·175	2·28 — 3·77	·670 — 1·110
BSEA 6 Abasement	2¼ × 2¼	·175 — ·300	·250 ·175	2·57 — 4·28	·757 — 1·260
BSEA 7 Abashed	2½ × 2½	·250 ·375 ·500	·275 ·200	4·04 5·89 7·65	1·187 1·733 2·249

BRITISH STANDARD SECTIONS

EQUAL ANGLES

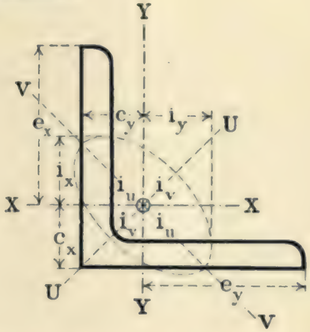
c_x c_y Distance of Centre of Gravity from back lines of Angle.

$I = a\,i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distances of outer fibres from X and Y axes.

$R = \frac{I}{e}$ Moment of Resistance.



8	9	10	11	12	13	14	15	16	17	18	19	20
Centre of Gravity		Moments of Inertia				Radii of Gyration				Moments of Resistance		BSEA No.
				Max.	Min.			Max.	Min.			
c_x	c_y	I_x	I_y	I_u	I_v	i_x	i_y	i_u	i_v	R_x	R_y	
inches		inches⁴		inches⁴		inches		inches		inches³		
·285 — —	·285 — —	·020 — —	·020 — —	·032 — —	·008 — —	·292 — —	·292 — —	·370 — —	·185 — —	·028 — —	·028 — —	1
·346 — —	·346 — —	·041 — —	·041 — —	·065 — —	·017 — —	·370 — —	·370 — —	·470 — —	·238 — —	·045 — —	·045 — —	2
·409 — —	·409 — —	·074 — —	·074 — —	·117 — —	·031 — —	·453 — —	·453 — —	·572 — —	·293 — —	·068 — —	·068 — —	3
·490 — —	·490 — —	·162 — —	·162 — —	·257 — —	·067 — —	·527 — —	·527 — —	·664 — —	·339 — —	·129 — —	·129 — —	4
·549 — —	·549 — —	·244 — —	·244 — —	·387 — —	·101 — —	·603 — —	·603 — —	·760 — —	·388 — —	·168 — —	·168 — —	5
·611 — —	·611 — —	·354 — —	·354 — —	·562 — —	·146 — —	·684 — —	·684 — —	·862 — —	·439 — —	·216 — —	·216 — —	6
·703 — —	·703 — —	·677 — —	·677 — —	1·076 — —	·278 — —	·755 — —	·755 — —	·952 — —	·485 — —	·377 — —	·377 — —	7

BRITISH STANDARD SECTIONS

EQUAL ANGLES

(continued)

1	2	3	4	5	6	7
Reference No. and Code Word.	Size.	Standard Thickness	Radii		Weight per foot.	Sectional Area
	A × B	t	r_1	r_2	w	a
	inches	inches	inches		lbs.	inches^2
BSEA 8 Abashing	2¾ × 2¾	·250 ·375 ·500	·275	·200	4·46 6·53 8·50	1·312 1·921 2·499
BSEA 9 Abatable	3 × 3	·250 ·375 ·500	·300	·200	4·90 7·18 9·36	1·440 2·111 2·752
BSEA 10 Abater	3½ × 3½	·300 ·425 ·500	·325	·225	6·84 9·50 11·05	2.011 2·795 3·251
BSEA 11 Abatjour	4 × 4	·300 ·425 ·500	·350	·250	7·85 10·94 12·75	2·310 3·219 3·749
BSEA 12 Abattis	4½ × 4½	·375 — ·500	·400	·275	11·00 — 14·46	3·236 — 4·252
BSEA 13 Abbacy	5 × 5	·375 — ·500	·425	·300	12·27 — 16·15	3·610 — 4·750
BSEA 14 Abbatial	6 × 6	·450 — ·625	·475	·325	17·68 — 24·18	5·201 — 7·112
BSEA 15 Abbey	7 × 7	·500 — ·675	·550	·375	22·97 — 30·60	6·755 — 8·999
BSEA 16 Abbeyland	8 × 8	·550 — ·750	·600	·425	28·89 — 38·89	8·497 — 11·437

BRITISH STANDARD SECTIONS

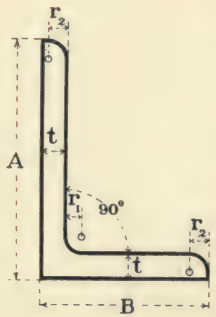
EQUAL ANGLES

(continued)

8	9	10	11	12	13	14	15	16	17	18	19	20
Centre of Gravity		Moments of Inertia				Radii of Gyration				Moments of Resistance		BSEA No.
				Max.	Min.			Max.	Min.			
c_x	c_y	I_x	I_y	I_u	I_v	i_x	i_y	i_u	i_v	R_x	R_y	
inches		inches^4		inches^4		inches		inches		inches^3		
·765	·765	·917	·917	1·457	·377	·836	·836	1·054	·535	·462	·462	8
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
·827	·827	1·207	1·207	1·919	·495	·916	·916	1·154	·587	·555	·555	9
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
·969	·969	2·299	2·299	3·656	·942	1·069	1·069	1·348	·684	·908	·908	10
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
1·091	1·091	3·477	3·477	5·531	1·423	1·227	1·227	1·548	·785	1·195	1·195	11
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
1·244	1·244	6·141	6·141	9·768	2·514	1·378	1·378	1·737	·882	1·886	1·886	12
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
1·365	1·365	8·510	8·510	13·540	3·480	1·535	1·535	1·937	·982	2·341	2·341	13
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
1·643	1·643	17·741	17·741	28·236	7·246	1·847	1·847	2·330	1·180	4·072	4·072	14
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
1·907	1·907	31·448	31·448	50·054	12·842	2·158	2·158	2·722	1·379	6·175	6·175	15
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	
2·172	2·172	51·801	51·801	82·472	21·130	2·469	2·469	3·115	1·577	8·889	8·889	16
—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	

BRITISH STANDARD SECTIONS

UNEQUAL ANGLES



a = Sectional Area.

W = 3·4a Weight in lbs. per foot.

1	2	3	4	5	6	7
Reference No. and Code Word	Size	Standard Thickness	Radii		Weight per foot	Sectional Area
	A × B	t	r_1	r_2	W	a
	inches	inches	inches		lbs.	inches²
BSUA 1 Abbot	1¼ × 1	·125 — ·250	·175	·125	·90 — 1·70	·265 — ·500
BSUA 2 Abbreviate	1½ × 1¼	·125 — ·250	·200	·150	1·11 — 2·12	·327 — ·624
BSUA 3 Abderian	1¾ × 1½	·175 — ·300	·225	·150	1·83 — 3·01	·539 — ·886
BSUA 4 Abdicable	2 × 1½	·175 — ·300	·225	·150	1·98 — 3·27	·583 — ·961
BSUA 5 Abdicated	2½ × 2	·175 — ·300	·250	·175	2·57 — 4·28	·757 — 1·260
BSUA 6 Abdicating	3 × 2	·250 ·375 ·500	·275	·200	4·04 5·89 7·65	1·187 1·733 2·249
BSUA 7 Abdicatrix	3 × 2½	·250 ·375 ·500	·275	·200	4·46 6·53 8·50	1·312 1·921 2·499
BSUA 8 Abditory	3½ × 2½	·250 ·375 ·500	·300	·200	4·90 7·18 9·36	1·440 2·112 2·752

List 2

BRITISH STANDARD SECTIONS

UNEQUAL ANGLES

c_x c_y Distance of Centre of Gravity from back lines of Angle.

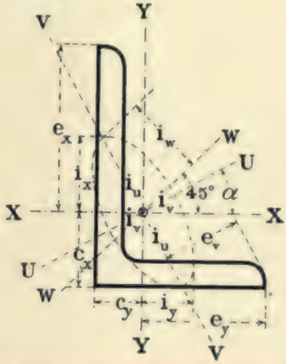
$I = a\,i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

$\text{Tan. } 2\alpha = \dfrac{I_x + I_y - 2I_w}{I_y - I_x}$

e_x e_y e_v Distances of outer fibres from X, Y and V axes.

$R_v = \dfrac{I_v}{e_v}$ Minimum Moment of Resistance.



8	9	10	11	12	13	14	15	16	17	18	19	20
Centre of Gravity		Moments of Inertia				Radii of Gyration				Angle	Moments of Resistance	
c_x	c_y	I_x	I_y	Max. I_u	Min. I_v	i_x	i_y	Max. i_u	Min. i_v	α	R_x	R_y
inches		inches^4		inches^4		inches		inches		tan. α	inches^3	
·381	·259	·038	·022	·049	·011	·384	·288	·430	·204	·615	·044	·030
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
·438	·317	·068	·043	·090	·021	·456	·363	·525	·253	·671	·064	·046
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
·522	·400	·154	·104	·207	·051	·535	·439	·620	·308	·715	·125	·095
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
·622	·376	·225	·108	·275	·058	·621	·430	·687	·315	·543	·163	·096
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
·741	·495	·460	·260	·586	·134	·780	·586	·880	·421	·622	·262	·173
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
·976	·482	1·056	·373	1·213	·216	·943	·561	1·011	·427	·433	·522	·245
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
·895	·648	1·138	·716	1·498	·356	·931	·739	1·069	·521	·678	·541	·387
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·095	·602	1·758	·748	2·091	·415	1·105	·721	1·205	·537	·498	·743	·394
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—

BRITISH STANDARD SECTIONS

UNEQUAL ANGLES

(continued)

1	2	3	4	5	6	7
Reference No. and Code Word	Size	Standard Thickness	Radii		Weight per foot	Sectional Area
	A × B	t	r_1	r_2	w	a
	inches	inches	inches		lbs.	inches²
BSUA 9 Abdominous	3½ × 3	·250 ·375 ·500	·325	·225	5·31 7·81 10·20	1·563 2·298 3·001
BSUA 10 Abducting	4 × 2½	·250 ·375 ·500	·325	·225	5·31 7·81 10·20	1·563 2·298 3·001
BSUA 11 Abecedary	4 × 3	·300 ·425 ·500	·325	·225	6·84 9·50 11·05	2·011 2·795 3·251
BSUA 12 Abelite	4 × 3½	·300 ·425 ·500	·350	·250	7·34 10·22 11·90	2·159 3·006 3·499
BSUA 13 Abelmosk	4½ × 3	·300 ·425 ·500	·350	·250	7·34 10·22 11·90	2·159 3·006 3·499
BSUA 14 Abelonian	4½ × 3½	·300 ·425 ·500	·350	·250	7·85 10·94 12·75	2·309 3·219 3·749
BSUA 15 Abeltree	5 × 3	·300 ·425 ·500	·350	·250	7·85 10·94 12·75	2·309 3·219 3·749
BSUA 16 Aberrancy	5 × 3½	·375 — ·500	·375	·250	10·37 — 13·61	3·050 — 4·003
BSUA 17 Aberration	5 × 4	·375 — ·500	·400	·275	11·00 — 14·46	3·236 — 4·252
BSUA 18 Abetment	5½ × 3	·375 — ·500	·375	·250	10·37 — 13·61	3·050 — 4·003
BSUA 19 Abetted	5½ × 3½	·375 — ·500	·400	·275	11·00 — 14·46	3·236 — 4·252

BRITISH STANDARD SECTIONS

UNEQUAL ANGLES

(continued)

8	9	10	11	12	13	14	15	16	17	18	19	20
Centre of Gravity		Moments of Inertia				Radii of Gyration				Angle	Moments of Resistance	
				Max.	Min.			Max.	Min.			
c_x	c_y	I_x	I_y	I_u	I_v	i_x	i_y	i_u	i_v	α	R_x	R_y
inches		inches⁴		inches⁴		inches		inches		tan. α	inches³	
1·014	·767	1·853	1·254	2·499	·608	1·089	·896	1·264	·624	·720	·745	·562
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·300	·561	2·535	·767	2·847	·455	1·274	·701	1·350	·540	·387	·939	·396
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·235	·741	3·188	1·537	3·899	·826	1·259	·874	1·392	·641	·549	1·153	·680
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·157	·910	3·334	2·378	4·583	1·129	1·243	1·049	1·457	·723	·752	1·173	·918
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·438	·697	4·407	1·574	5·076	·905	1·429	·854	1·533	·647	·437	1·439	·683
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·355	·860	4·641	2·460	5·815	1·286	1·418	1·032	1·587	·746	·591	1·476	·932
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·651	·662	5·908	1·617	6·552	·973	1·600	·837	1·685	·649	·361	1·764	·692
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·590	·848	7·644	3·095	9·005	1·734	1·583	1·007	1·718	·754	·480	2·242	1·167
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·506	1·011	7·961	4·527	10·168	2·320	1·568	1·183	1·773	·847	·625	2·278	1·515
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·899	·662	9·448	2·019	10·204	1·263	1·760	·814	1·829	·644	·304	2·624	·864
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·797	·807	9·932	3·155	11·233	1·854	1·752	·987	1·863	·757	·401	2·682	1·172
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—

BRITISH STANDARD SECTIONS

UNEQUAL ANGLES

(continued)

1	2	3	4	5	6	7
Reference No. and Code Word	Size A × B	Standard Thickness t	Radii r_1	r_2	Weight per foot w	Sectional Area a
	inches	inches	inches		lbs.	inches²
BSUA 20 Abetting	6 × 3½	·375 — ·500	·400	·275	11·64 — 15·31	3·424 — 4·502
BSUA 21 Abettors	6 × 4	·375 — ·500	·425	·300	12·27 — 16·15	3·610 — 4·750
BSUA 22 Abeyance	6½ × 3½	·375 — ·500	·425	·300	12·27 — 16·15	3·610 — 4·750
BSUA 23 Abhorrency	6½ × 4	— ·525 —	·425	·300	— 17·81 —	— 5·237 —
BSUA 24 Abhorrible	6½ × 4½	— ·550 —	·450	·325	— 19·54 —	— 5·746 —
BSUA 25 Abhorring	7 × 3½	— ·525 —	·425	·300	— 17·81 —	— 5·237 —
BSUA 26 Abiders	7 × 4	— ·550 —	·450	·325	— 19·54 —	— 5·746 —
BSUA 27 Abidingly	8 × 3½	— ·575 —	·475	·325	— 21·37 —	— 6·285 —
BSUA 28 Abietic	8 × 4	— ·625 —	·475	·325	— 24·18 —	— 7·112 —
BSUA 29 Abigail	9 × 4	— ·650 —	·500	·350	— 27·30 —	— 8·029 —
BSUA 30 Abilities	10 × 4	— ·675 —	·550	·375	— 30·60 —	— 8·999 —

BRITISH STANDARD SECTIONS

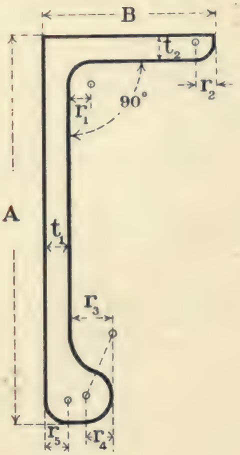
UNEQUAL ANGLES

(continued)

8	9	10	11	12	13	14	15	16	17	18	19	20
Centre of Gravity		Moments of Inertia				Radii of Gyration				Angle	Moments of Resistance	
				Max.	Min.			Max.	Min.			
c_x	c_y	I_x	I_y	I_u	I_v	i_x	i_y	i_u	i_v	α	R_x	R_y
inches		inches[4]		inches[4]		inches		inches		tan. α	inches[3]	
2·011	·773	12·646	3·225	13·908	1·963	1·922	·971	2·015	·757	·344	3·170	1·183
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1·912	·923	13·191	4·731	15·209	2·713	1·912	1·145	2·053	·867	·439	3·227	1·538
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·225	·741	15·728	3·266	16·949	2·045	2·087	·951	2·167	·753	·299	3·679	1·184
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·188	·948	22·359	6·498	24·968	3·889	2·066	1·114	2·183	·862	·376	5·185	2·129
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·104	1·111	24·213	9·508	28·351	5·370	2·053	1·286	2·221	·967	·469	5·508	2·806
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·512	·775	26·213	4·456	27·789	2·880	2·237	·922	2·304	·742	·260	5·841	1·635
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·412	·923	28·580	6·858	31·207	4·231	2·230	1·092	2·330	·858	·329	6·229	2·229
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·979	·747	41·121	4·934	42·736	3·319	2·558	·886	2·608	·727	·207	8·190	1·792
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
2·883	·896	46·436	7·890	49·218	5·108	2·555	1·053	2·631	·847	·260	9·075	2·542
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
3·341	·858	66·566	8·342	69·324	5·584	2·879	1·019	2·938	·834	·213	11·763	2·655
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
3·805	·827	92·109	8·773	94·848	6·034	3·199	·987	3·247	·819	·178	14·868	2·765
—	—	—	—	—	—	—	—	—	—	—	—	—

BRITISH STANDARD SECTIONS

BULB ANGLES



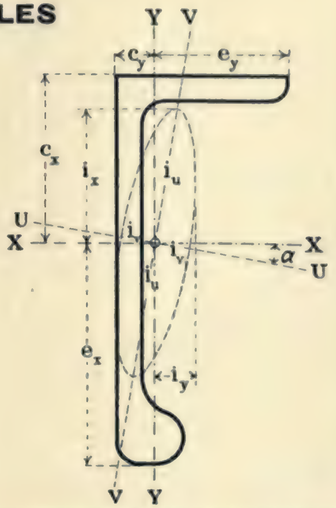
a = Sectional Area.

W = 3·4**a** Weight in lbs. per foot.

1	2	3	4	5	6	7	8	9	10	11
Reference No. and Code Word	Size	Standard Thickness		Radii					Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	r_3	r_4	r_5	W	a
	inches	inches		inches					lbs.	inches²
BSBA 1 Abiogenist	4 × 2½	·300		·300	·200	·525	·300	·250	7·38	2·170
BSBA 2 Abiogenous	5 × 2½	·325		·350	·250	·600	·350	·300	9·33	2·743
BSBA 3 Abiogeny	5½ × 3	·350		·375	·250	·650	·375	·325	11·33	3·332
BSBA 4 Abject	6 × 3	·375		·400	·275	·675	·400	·325	12·79	3·763
BSBA 5 Abjection	6½ × 3	·375		·425	·275	·700	·425	·350	13·61	4·002
BSBA 6 Abjectly	6½ × 3½	·400		·425	·275	·700	·425	·350	15·03	4·420
BSBA 7 Abjectness	7 × 3	·400		·450	·300	·750	·450	·375	15·29	4·498

BRITISH STANDARD SECTIONS

BULB ANGLES



c_x c_y Distance of Centre of Gravity from back lines of Angle.

$I = a\,i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distances of outer fibres from X and Y axes.

$R = \frac{I}{e}$ Moment of Resistance.

12	13	14	15	16	17	18	19	20	21	22	23	24
Centre of Gravity		Moments of Inertia				Radii of Gyration				Angle	Moments of Resistance	
				Max.	Min.			Max.	Min.			
c_x	c_y	I_x	I_y	I_u	I_v	i_x	i_y	i_u	i_v	α	R_x	R_y
inches		inches⁴		inches⁴		inches		inches		tan. α	inches³	
1·661	·577	4·461	·915	4·724	·652	1·434	·649	1·475	·548	·263	1·907	·476
2·193	·538	8·802	1·021	9·024	·799	1·791	·610	1·814	·540	·167	3·136	·520
2·346	·649	13·032	1·909	13·520	1·421	1·978	·757	2·014	·653	·205	4·132	·812
2·597	·638	17·350	2·057	17·826	1·581	2·147	·739	2·177	·648	·174	5·098	·871
2·865	·619	21·677	2·098	22·117	1·658	2·327	·724	2·351	·644	·148	5·963	·881
2·723	·747	23·943	3·494	24·857	2·580	2·327	·889	2·371	·764	·207	6·339	1·269
3·141	·614	28·063	2·250	28·484	1·829	2·498	·707	2·516	·638	·127	7·272	·943

BRITISH STANDARD SECTIONS

BULB ANGLES

(continued)

1	2	3	4	5	6	7	8	9	10	11
Reference No. and Code Word	Size	Standard Thickness		Radii					Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	r_3	r_4	r_5	w	a
	inches	inches		inches					lbs.	inches²
BSBA 8 Abjuration	7 × 3½	·425		·450	·300	·750	·450	·375	16·80	4·940
BSBA 9 Abjuratory	7½ × 3	·425		·475	·325	·800	·475	·400	17·08	5·023
BSBA 10 Abjured	7½ × 3½	·425		·475	·325	·800	·475	·400	17·80	5·236
BSBA 11 Abjuring	8 × 3	·425		·500	·325	·825	·500	·400	18·02	5·301
BSBA 12 Abjuror	8 × 3½	·450		·500	·325	·825	·500	·400	19·65	5·779
BSBA 13 Ablatival	8½ × 3	·450		·525	·350	·850	·525	·425	19·85	5·837
BSBA 14 Ablative	8½ × 3½	·475		·525	·350	·850	·525	·425	21·55	6·339
BSBA 15 Ablaze	9 × 3	·475		·550	·350	·900	·550	·450	21·89	6·439
BSBA 16 Ablebodied	9 × 3½	·475		·550	·350	·900	·550	·450	22·70	6·677
BSBA 17 Ableminded	9½ × 3½	·500		·550	·375	·950	·550	·475	24·74	7·277
BSBA 18 Ableness	10 × 3½	·525		·575	·400	·975	·575	·500	26·87	7·904
BSBA 19 Ablepsy	11 × 3½	·550		·625	·425	1·050	·625	·525	30·44	8·953
BSBA 20 Abloom	12 × 4	·600		·675	·450	1·125	·675	·550	36·46	10·724

List 3

BRITISH STANDARD SECTIONS

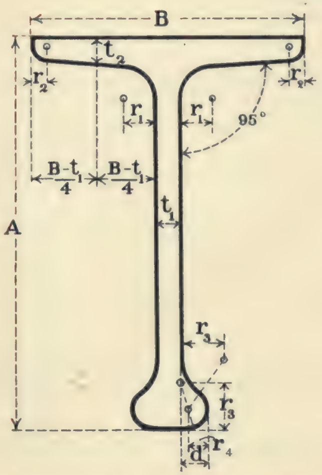
BULB ANGLES

(continued)

12	13	14	15	16	17	18	19	20	21	22	23	24
Centre of Gravity		Moments of Inertia				Radii of Gyration				Angle	Moments of Resistance	
				Max.	Min.			Max.	Min.			
c_x	c_y	I_x	I_y	I_u	I_v	i_x	i_y	i_u	i_v	α	R_x	R_y
inches		inches^4		inches^4		inches		inches		tan. α	inches^3	
2·998	·737	30·914	3·730	31·809	2·835	2·502	·869	2·538	·758	·179	7·725	1·350
3·419	·612	35·725	2·405	36·123	2·007	2·667	·692	2·682	·632	·109	8·754	1·007
3·290	·717	37·824	3·772	38·648	2·948	2·688	·849	2·717	·750	·154	8·984	1·355
3·698	·600	42·863	2·449	43·231	2·081	2·844	·680	2·856	·627	·095	9·964	1·020
3·543	·712	47·072	4·031	47·887	3·216	2·854	·835	2·879	·746	·136	10·561	1·446
3·956	·598	52·685	2·603	53·038	2·250	3·004	·668	3·014	·621	·084	11·594	1·084
3·798	·706	57·725	4·265	58·521	3·469	3·018	·820	3·038	·740	·121	12·277	1·526
4·238	·603	64·712	2·792	65·042	2·462	3·170	·658	3·178	·618	·073	13·589	1·165
4·095	·695	68·383	4·336	69·116	3·603	3·200	·806	3·217	·735	·106	13·941	1·546
4·361	·694	82·418	4·585	83·131	3·872	3·365	·794	3·380	·729	·095	16·038	1·634
4·622	·693	98·228	4·828	98·917	4·139	3·525	·782	3·538	·724	·085	18·265	1·720
5·188	·686	133·856	5·170	134·444	4·582	3·867	·760	3·875	·715	·068	23·031	1·837
5·585	·778	191·443	8·355	192·575	7·223	4·225	·883	4·238	·821	·078	29·843	2·593

BRITISH STANDARD SECTIONS

BULB TEES



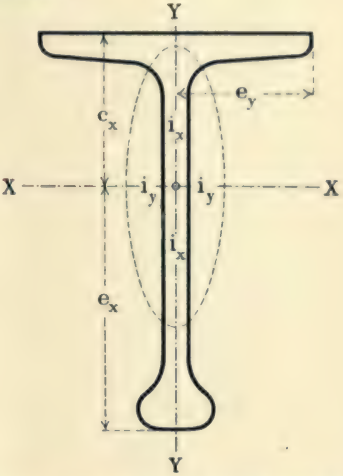
a = Sectional Area.

W = 3·4 **a** Weight in lbs. per foot.

1	2	3	4	5	6	7	8	9	10	11
Reference No. and Code Word	Size	Standard Thickness			Radii				Weight per foot	Sectional Area
	A × B	t_1	t_2	d	r_1	r_2	r_3	r_4	W	a
	inches	inches		inches	inches				lbs.	inches^2
BSBT 1 Ablution	7 × 5	·425	·425	·450	·600	·200	·800	·300	19·01	5·592
BSBT 2 Abnegateth	8 × 5½	·450	·450	·500	·675	·225	·900	·325	22·78	6·701
BSBT 3 Abnegation	9 × 5½	·475	·500	·575	·750	·250	1·000	·375	26·76	7·870
BSBT 4 Abnegators	10 × 6	·500	·550	·625	·825	·275	1·100	·400	31·60	9·295
BSBT 5 Abnormal	11 × 6½	·550	·600	·675	·900	·300	1·200	·450	37·86	11·136
BSBT 6 Abnormity	12 × 6½	·575	·650	·725	·975	·325	1·300	·475	42·49	12·498

BRITISH STANDARD SECTIONS

BULB TEES



c_x c_y Distance of Centre of Gravity from top line and Y axis.

$I = ai^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distance of outer fibres from X and Y axes.

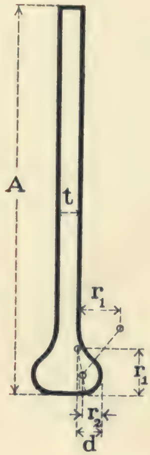
$R = \frac{I}{e}$ Moment of Resistance.

12	13	14	15	16	17	18	19	20
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSBT No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches[4]		inches		inches[3]		
2·611	0	35·087	4·021	2·505	·848	7·994	1·608	1
3·018	0	55·377	5·628	2·875	·916	11·115	2·046	2
3·524	0	83·730	6·410	3·262	·902	15·290	2·331	3
3·881	0	122·278	9·124	3·627	·991	19·984	3·041	4
4·290	0	177·041	12·690	3·983	1·067	26·324	3·905	5
4·759	0	236·808	13·965	4·353	1·057	32·704	4·297	6

List 5

BRITISH STANDARD SECTIONS

BULB PLATES



a = Sectional Area.

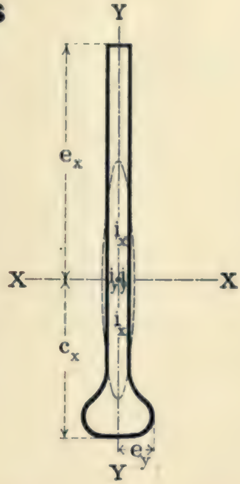
$W = 3{\cdot}4\,a$ Weight in lbs. per foot.

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A	t	d	r_1	r_2	W	a
	inches	inches	inches	inches		lbs.	inches^2
BSBP 1 Abnormous	6	·300	·400	·700	·250	7·58	2·230
BSBP 2 Abode	7	·350	·450	·800	·300	10·24	3·011
BSBP 3 Abolish	8	·400	·500	·900	·325	13·22	3·887
BSBP 4 Abolished	9	·450	·575	1·000	·375	16·86	4·958
BSBP 5 Abolishers	10	·500	·625	1·100	·400	20·60	6·059
BSBP 6 Abolishing	11	·550	·675	1·200	·450	24·87	7·315
BSBP 7 Abolition	12	·600	·725	1·300	·475	29·42	8·652

List 5

BRITISH STANDARD SECTIONS

BULB PLATES



c_x c_y Distance of Centre of Gravity from bottom line and Y axis.

$I = a\,i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distance of outer fibres from X and Y axes.

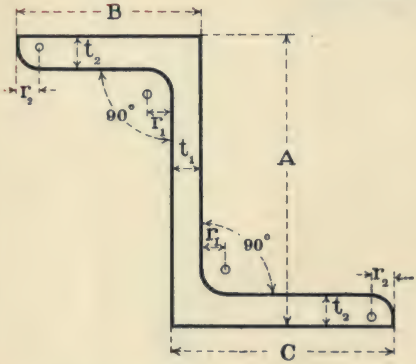
$R = \frac{I}{e}$ Moment of Resistance.

9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSBP No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches^4		inches		inches^3		
2·487	0	7·899	·060	1·882	·164	2·248	·109	1
2·920	0	14·440	·104	2·190	·186	3·539	·167	2
3·370	0	24·314	·165	2·501	·206	5·251	·235	3
3·767	0	39·295	·277	2·815	·236	7·509	·346	4
4·219	0	59·193	·399	3·126	·257	10·239	·456	5
4·650	0	86·411	·571	3·437	·279	13·608	·601	6
5·100	0	121·398	·775	3·746	·299	17·594	·756	7

List 6

BRITISH STANDARD SECTIONS

Z BARS



a = Sectional Area.

W = 3·4 **a** Weight in lbs. per foot.

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B × C	t_1	t_2	r_1	r_2	W	a
	inches	inches		inches		lbs.	inches²
BSZ 1 **Abominable**	3 × 2½ × 3	·300	·400	·325	·225	9·81	2·884
BSZ 2 **Abominated**	4 × 2½ × 3	·325	·425	·350	·225	11·53	3·392
BSZ 3 **Abominator**	5 × 3 × 3	·350	·450	·375	·250	14·17	4·169
BSZ 4 **Aborally**	6 × 3½ × 3½	·375	·475	·425	·300	17·88	5·258
BSZ 5 **Aboriginal**	7 × 3½ × 3½	·400	·500	·450	·300	20·22	5·948
BSZ 6 **Aborigines**	8 × 3½ × 3½	·425	·525	·450	·325	22·68	6·670
BSZ 7 **Abortional**	9 × 3½ × 3½	·450	·550	·475	·350	25·33	7·449
BSZ 8 **Abortively**	10 × 3½ × 3½	·475	·575	·500	·350	28·16	8·283

List 6

BRITISH STANDARD SECTIONS

Z BARS

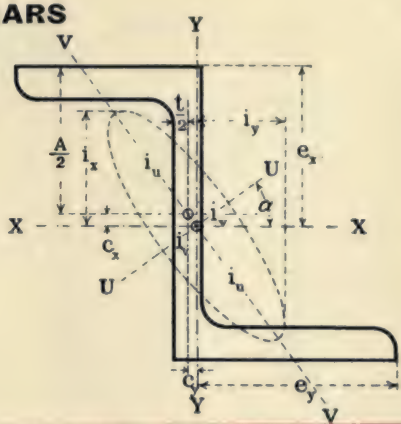
c_x c_y Distance of Centre of Gravity from axes, as shown.

$I = ai^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distances of outer fibres from X and Y axes.

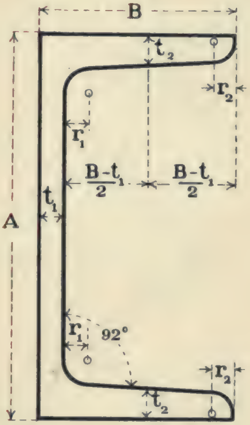
$R = \frac{I}{e}$ Moment of Resistance.



9	10	11	12	13	14	15	16	17	18	19	20	21
Centre of Gravity		Moments of Inertia				Radii of Gyration				Angle	Moments of Resistance	
c_x	c_y	I_x	I_y	Max. I_u	Min. I_v	i_x	i_y	Max. i_u	Min. i_v	a	R_x	R_y
inches		inches^4		inches^4		inches		inches		tan. a	inches^3	
·090	·178	4·009	4·591	7·749	·851	1·179	1·262	1·639	·543	·919	2·521	1·718
·112	·160	8·368	4·831	11·886	1·313	1·571	1·193	1·872	·622	·706	3·962	1·805
0	0	16·145	6·578	20·694	2·029	1·968	1·256	2·228	·698	·568	6·458	2·328
0	0	29·660	11·134	37·251	3·543	2·375	1·455	2·662	·821	·539	9·887	3·361
0	0	44·609	11·618	52·035	4·192	2·739	1·398	2·958	·840	·429	12·745	3·521
0	0	63·729	12·024	70·991	4·762	3·091	1·343	3·262	·845	·351	15·932	3·657
0	0	87·889	12·418	95·011	5·296	3·435	1·291	3·571	·843	·294	19·531	3·792
0	0	117·865	12·876	124·912	5·829	3·772	1·247	3·883	·839	·251	23·573	3·947

BRITISH STANDARD SECTIONS

CHANNELS



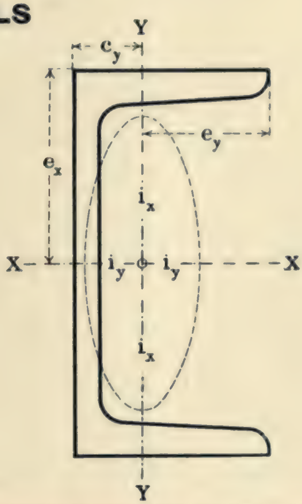
a = Sectional Area.

W = 3·4 **a** Weight in lbs. per foot.

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	W	a
	inches	inches		inches		lbs.	inches^2
BSC 1 Abound	3 × 1½	·250	·312	·312	·220	5·27	1·549
BSC 2 Aboundeth	3½ × 2	·250	·312	·312	·220	6·75	1·986
BSC 3 Aboveboard	4 × 2	·250	·375	·375	·260	7·96	2·341
BSC 4 Abovecited	5 × 2½	·312	·375	·375	·260	10·98	3·230
BSC 5 Abovesaid	6 × 2½	·312	·375	·375	·260	12·04	3·542
BSC 6 Abrade	6 × 3	·312	·437	·437	·300	14·49	4·261
BSC 7 Abrading	6 × 3	·375	·475	·475	·325	16·29	4·791

BRITISH STANDARD SECTIONS

CHANNELS



c_x c_y Distance of Centre of Gravity from X axis and back line of Channel.

$I = a\,i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distances of outer fibres from X and Y axes.

$R = \frac{I}{e}$ Moment of Resistance.

9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSC No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches⁴		inches		inches³		
0	·484	1·994	·296	1·135	·437	1·329	·291	1
0	·645	3·701	·713	1·365	·599	2·115	·526	2
0	·656	5·709	·843	1·562	·600	2·855	·627	3
0	·757	12·134	1·774	1·938	·741	4·854	1·018	4
0	·704	18·763	1·880	2·302	·729	6·254	1·047	5
0	·938	24·010	3·503	2·374	·907	8·003	1·699	6
0	·928	26·034	3·822	2·331	·893	8·678	1·845	7

BRITISH STANDARD SECTIONS

CHANNELS

(continued)

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	w	a
	inches	inches		inches		lbs.	inches^2
BSC 8 Abrasion	6 × 3½	·375	·475	·475	·325	17·90	5·266
BSC 9 Abrazite	7 × 3	·375	·475	·475	·325	17·56	5·166
BSC 10 Abreast	7 × 3½	·400	·500	·500	·350	20·23	5·950
BSC 11 Abrenounce	8 × 2½	·312	·437	·437	·300	15·12	4·448
BSC 12 Abridged	8 × 3	·375	·500	·500	·350	19·30	5·675
BSC 13 Abridging	8 × 3½	·425	·525	·525	·375	22·72	6·682
BSC 14 Abridgment	8 × 4	·450	·550	·550	·375	25·73	7·569
BSC 15 Abroach	9 × 3	·375	·437	·437	·350	19·37	5·696
BSC 16 Abrogable	9 × 3½	·375	·500	·500	·350	22·27	6·550
BSC 17 Abrogates	9 × 3½	·450	·550	·550	·375	25·39	7·469
BSC 18 Abrogating	9 × 4	·475	·575	·575	·400	28·55	8·396
BSC 19 Abrogation	10 × 3½	·375	·500	·500	·350	23·55	6·925
BSC 20 Abrook	10 × 3½	·475	·575	·575	·400	28·21	8·296

BRITISH STANDARD SECTIONS

CHANNELS

(continued)

9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSC No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches⁴		inches		inches³		
0	1·119	29·656	5·907	2·373	1·059	9·885	2·481	8
0	·874	37·627	4·017	2·699	·882	10·751	1·889	9
0	1·061	44·549	6·498	2·736	1·045	12·728	2·664	10
0	·666	41·094	2·283	3·040	·716	10·273	1·245	11
0	·844	53·432	4·329	3·068	·873	13·358	2·008	12
0	1·011	63·763	7·067	3·089	1·028	15·941	2·839	13
0	1·201	74·018	10·790	3·127	1·194	18·504	3·855	14
0	·754	65·177	4·021	3·383	·840	14·484	1·790	15
0	·976	79·902	6·963	3·493	1·031	17·756	2·759	16
0	·971	88·075	7·660	3·434	1·013	19·572	3·029	17
0	1·151	101·654	11·635	3·480	1·177	22·590	4·084	18
0	·933	102·622	7·187	3·850	1·019	20·524	2·800	19
0	·933	117·959	8·194	3·771	·994	23·592	3·192	20

List 7

BRITISH STANDARD SECTIONS

CHANNELS

(continued)

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	w	a
	inches	inches		inches		lbs.	inches²
BSC 21 Abrotanoid	10 × 4	·475	·575	·575	·400	30·16	8·871
BSC 22 Abrothrix	11 × 3½	·475	·575	·575	·400	29·82	8·771
BSC 23 Abrupt	11 × 4	·500	·600	·600	·425	33·22	9·771
BSC 24 Abruption	12 × 3½	·375	·500	·500	·350	26·10	7·675
BSC 25 Abruptly	12 × 3½	·500	·600	·600	·425	32·88	9·671
BSC 26 Abruptness	12 × 4	·525	·625	·625	·425	36·47	10·727
BSC 27 Abscess	15 × 4	·525	·630	·630	·440	41·94	12·334

List 7

BRITISH STANDARD SECTIONS

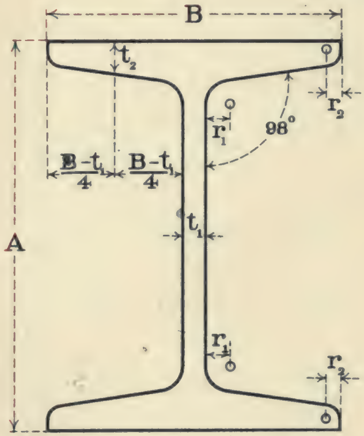
CHANNELS

(continued)

9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSC No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches^4		inches		inches^3		
0	1·102	130·715	12·018	3·839	1·164	26·143	4·147	21
0	·896	148·606	8·421	4·116	·980	27·019	3·234	22
0	1·063	170·454	12·812	4·177	1·145	30·992	4·362	23
0	·860	158·639	7·572	4·546	·993	26·440	2·868	24
0	·867	190·735	8·922	4·441	·960	31·789	3·389	25
0	1·031	218·181	13·654	4·510	1·128	36·363	4·599	26
0	·935	377·007	14·554	5·529	1·086	50·268	4·748	27

BRITISH STANDARD SECTIONS

BEAMS



a = Sectional Area.

w = 3·4 **a** Weight in lbs. per foot.

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	w	a
	inches	inches		inches		lbs.	inches²
BSB 1 Abscession	3 × 1½	·160	·248	·260	·130	4·00	1·176
BSB 2 Abscind	3 × 3	·200	332	·300	·150	8·50	2·501
BSB 3 Absconding	4 × 1¾	·170	·240	·270	·135	5·00	1·472
BSB 4 Absented	4 × 3	·220	·336	·320	·160	9·50	2·795
BSB 5 Absentees	4¾ × 1¾	·180	·325	·280	·140	6·50	1·912
BSB 6 Absenting	5 × 3	·220	·376	·320	·160	11·01	3·238
BSB 7 Absently	5 × 4½	·290	·448	·390	·195	17·99	5·290

BRITISH STANDARD SECTIONS

BEAMS

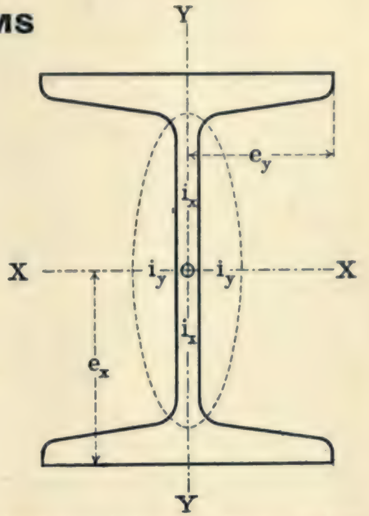
c_x c_y Distance of Centre of Gravity from X axis and Y axis.

$I = a\,i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distance of outer fibres from X and Y axes.

$R = \frac{I}{e}$ Moment of Resistance.



9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSB No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches⁴		inches		inches³		
0	0	1·657	·124	1·187	·325	1·105	·165	1
0	0	3·789	1·261	1·231	·710	2·526	·841	2
0	0	3·671	·194	1·579	·363	1·835	·222	3
0	0	7·526	1·280	1·641	·677	3·763	·854	4
0	0	6·767	·263	1·881	·371	2·849	·300	5
0	0	13·620	1·461	2·051	·672	5·448	·974	6
0	0	22·699	5·656	2·071	1·034	9·080	2·514	7

BRITISH STANDARD SECTIONS

BEAMS

(continued)

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	w	a
	inches	inches		inches		lbs.	inches^2
BSB 8 Absentness	6 × 3	·260	·348	·360	·180	11·99	3·527
BSB 9 Absinthe	6 × 4½	·370	·431	·470	·235	20·00	5·882
BSB 10 Absinthine	6 × 5	·410	·520	·510	·255	25·00	7·354
BSB 11 Absolute	7 × 4	·250	·387	·350	·175	16·01	4·709
BSB 12 Absolution	8 × 4	·280	·402	·380	·190	18·01	5·297
BSB 13 Absolutory	8 × 5	·350	·575	·450	·225	28·02	8·241
BSB 14 Absolvable	8 × 6	·440	·597	·540	·270	35·00	10·293
BSB 15 Absolved	9 × 4	·300	·460	·400	·200	21·00	6·178
BSB 16 Absolving	9 × 7	·550	·924	·650	·325	58·02	17·064
BSB 17 Absonous	10 × 5	·360	·552	·460	·230	29·99	8·820
BSB 18 Absorb	10 × 6	·400	·736	·500	·250	42·02	12·358
BSB 19 Absorbable	10 × 8	·600	·970	·700	·350	69·98	20·582
BSB 20 Absorbing	12 × 5	·350	·550	·450	·225	31·99	9·408

BRITISH STANDARD SECTIONS

BEAMS

(continued)

9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSB No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches^4		inches		inches^3		
0	0	20·228	1·338	2·395	·616	6·743	·892	8
0	0	34·660	5·409	2·427	·959	11·553	2·404	9
0	0	43·641	9·105	2·436	1·113	14·547	3·642	10
0	0	39·222	3·410	2·886	·851	11·206	1·705	11
0	0	55·716	3·574	3·243	·821	13·929	1·787	12
0	0	89·357	10·250	3·293	1·115	22·339	4·100	13
0	0	110·597	17·929	3·278	1·320	27·649	5·976	14
0	0	81·115	4·198	3·624	·824	18·026	2·099	15
0	0	229·740	46·265	3·669	1·647	51·053	13·219	16
0	0	145·684	9·780	4·064	1·053	29·137	3·912	17
0	0	211·614	22·930	4·138	1·362	42·323	7·643	18
0	0	345·039	71·609	4·094	1·865	69·008	17·902	19
0	0	220·115	9·743	4·837	1·018	36·686	3·897	20

List 8

BRITISH STANDARD SECTIONS

BEAMS

(continued)

1	2	3	4	5	6	7	8
Reference No. and Code Word	Size	Standard Thickness		Radii		Weight per foot	Sectional Area
	A × B	t_1	t_2	r_1	r_2	W	a
	inches	inches		inches		lbs.	inches²
BSB 21 Absorption	12 × 6	·400	·717	·500	·250	44·02	12·946
BSB 22 Abstain	12 × 6	·500	·883	·600	·300	53·99	15·879
BSB 23 Abstainers	14 × 6	·400	·698	·500	·250	46·01	13·533
BSB 24 Abstaining	14 × 6	·500	·873	·600	·300	57·01	16·769
BSB 25 Abstemious	15 × 5	·420	·647	·520	·260	41·99	12·351
BSB 26 Abstergent	15 × 6	·500	·880	·600	·300	58·98	17·346
BSB 27 Absterse	16 × 6	·550	·847	·650	·325	61·97	18·227
BSB 28 Abstersive	18 × 7	·550	·928	·650	·325	75·02	22·066
BSB 29 Abstinence	20 × 7½	·600	1·010	·700	·350	88·96	26·164
BSB 30 Abstorted	24 × 7½	·600	1·070	·700	·350	99·93	29·392

BRITISH STANDARD SECTIONS

BEAMS

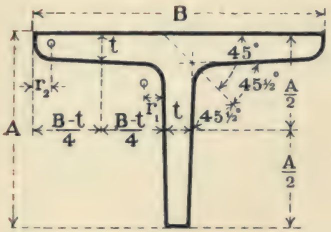
(continued)

9	10	11	12	13	14	15	16	17
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BSB No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches⁴		inches		inches³		
0	0	315·439	22·257	4·936	1·311	52·573	7·419	21
0	0	375·599	28·280	4·863	1·334	62·600	9·427	22
0	0	440·625	21·584	5·706	1·263	62·946	7·195	23
0	0	533·091	27·941	5·638	1·291	76·156	9·314	24
0	0	428·207	11·937	5·888	·983	57·094	4·775	25
0	0	629·094	28·203	6·022	1·275	83·879	9·401	26
0	0	725·953	27·069	6·311	1·219	90·744	9·023	27
0	0	1149·667	46·618	7·218	1·453	127·741	13·320	28
0	0	1671·291	62·586	7·992	1·547	167·129	16·690	29
0	0	2654·769	66·874	9·504	1·508	221·231	17·833	30

List 9

BRITISH STANDARD SECTIONS

T BARS



a = Sectional Area.

W = 3·4 **a** Weight in lbs. per foot.

1	2	3	4	5	6	7
Reference No. and Code Word	Size	Standard Thickness	Radii		Weight per foot	Sectional Area
	B × A	t	r_1	r_2	W	a
	inches	inches	inches		lbs.	inches^2
BST 1 Abstractly	1 × 1	·125 ·187 —	·175	·125	·82 1·17 —	·240 ·344 —
BST 2 Abstruded	1¼ × 1¼	·125 ·187 —	·200	·150	1·03 1·49 —	·303 ·438 —
BST 3 Abstrusely	1½ × 1½	·187 ·250 —	·200	·150	1·81 2·35 —	·531 ·692 —
BST 4 Abstrusion	1¾ × 1¾	·187 ·250 —	·225	·150	2·14 2·79 —	·629 ·820 —
BST 5 Absuming	1½ × 2	·250 ·312 —	·225	·150	2·79 3·40 —	·820 1·001 —
BST 6 Absurd	2 × 2	·250 ·312 ·375	·250	·175	3·22 3·94 4·64	·947 1·159 1·366
BST 7 Absurdest	2¼ × 2¼	·250 ·312 ·375	·250	·175	3·64 4·47 5·28	1·071 1·314 1·553
BST 8 Absurdity	2½ × 2½	·250 ·312 ·375	·275	·200	4·07 5·00 5·92	1·197 1·471 1·741
BST 9 Absurdness	3 × 2	·312 ·375 —	·275	·200	5·01 5·93 —	1·472 1·743 —

List 9

BRITISH STANDARD SECTIONS

T BARS

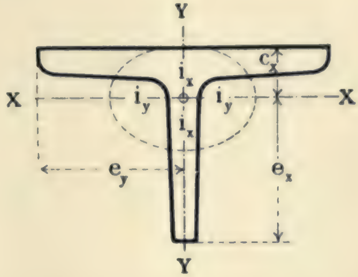
c_x c_y Distance of Centre of Gravity from top line and Y axis.

$I = a i^2$ Moment of Inertia.

$i = \sqrt{\frac{I}{a}}$ Radius of Gyration.

e_x e_y Distance of outer Fibres from X and Y axes.

$R = \frac{I}{e}$ Moment of Resistance.



8	9	10	11	12	13	14	15	16
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BST No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches^4		inches		inches^3		
·289	0	·021	·009	·296	·194	·030	·018	1
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·348	0	·042	·017	·372	·237	·047	·027	2
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·435	0	·106	·048	·447	·301	·100	·064	3
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·492	0	·173	077	·524	·350	·138	·088	4
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·648	0	·307	·068	·612	·288	·227	·091	5
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·579	0	·337	·157	·597	·407	·237	·157	6
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·638	0	·488	·224	·675	·457	·303	·199	7
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·697	0	·677	·302	·752	·502	·375	·242	8
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·509	0	·457	·666	·557	·673	·307	·444	9
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	

BRITISH STANDARD SECTIONS

T BARS

(continued)

1	2	3	4	5	6	7
Reference No. and Code Word	Size	Standard Thickness	Radii		Weight per foot	Sectional Area
	B × A	t	r_1	r_2	w	a
	inches	inches	inches		lbs.	inches ^{2}
BST 10 Abterminal	3 × 2½	·312 ·375 —	·275	·200	5·53 6·56 —	1·627 1·929 —
BST 11 Abundance	3 × 3	·312 ·375 ·437	·300	·200	6·08 7·21 8·30	1·788 2·121 2·441
BST 12 Abundant	3 × 4	·375 ·500 —	·325	·225	8·48 11·07 —	2·494 3·256 —
BST 13 Abusable	3½ × 3½	·375 ·437 ·500	·325	·225	8·49 9·78 11·08	2·496 2·878 3·258
BST 14 Abuseful	4 × 3	·375 ·500 —	·325	·225	8·49 11·08 —	2·498 3·260 —
BST 15 Abuseth	4 × 4	·375 ·500 —	·350	·250	9·77 12·78 —	2·872 3·758 —
BST 16 Abusing	4 × 5	·375 ·500 —	·400	·275	11·06 14·50 —	3·253 4·264 —
BST 17 Abusively	5 × 3	·375 ·500 —	·350	·250	9·78 12·79 —	2·875 3·762 —
BST 18 Abuttal	5 × 3½	·500 — —	·375	·250	13·66 — —	4·018 — —
BST 19 Abvolated	5 × 4	·500 — —	·400	·275	14·51 — —	4·268 — —
BST 20 Abysmal	6 × 3	·375 ·500 —	·400	·275	11·08 14·53 —	3·260 4·272 —
BST 21 Abyss	6 × 4	·500 — —	·425	·300	16·22 — —	4·771 — —
BST 22 Acacias	7 × 3½	·500 — —	·425	·300	17·08 — —	5·023 — —

List 9

BRITISH STANDARD SECTIONS

T BARS

(continued)

8	9	10	11	12	13	14	15	16
Centre of Gravity		Moments of Inertia		Radii of Gyration		Moments of Resistance		BST No.
c_x	c_y	I_x	I_y	i_x	i_y	R_x	R_y	
inches		inches^4		inches		inches^3		
·670	0	·869	·667	·731	·640	·475	·445	10
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·842	0	1·456	·669	·902	·612	·675	·446	11
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
1·244	0	3·822	·812	1·238	·571	1·387	·541	12
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·988	0	2·768	1·284	1·053	·717	1·102	·734	13
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·767	0	1·860	1·914	·863	·875	·833	·957	14
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
1·106	0	4·189	1·901	1·208	·814	1·447	·950	15
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
1·469	0	7·771	1·887	1·546	·762	2·201	·943	16
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·691	0	1·973	3·716	·828	1·137	·854	1·486	17
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·892	0	3·936	5·043	·990	1·120	1·509	2·017	18
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
1·052	0	5·772	5·017	1·163	1·084	1·958	2·007	19
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·633	0	2·062	6·389	·795	1·400	·871	2·130	20
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·968	0	6·070	8·621	1·128	1·344	2·002	2·874	21
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	
·764	0	4·285	13·699	·924	1·651	1·566	3·914	22
—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	